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ABSTRACT

These volumes are, respectively, the self-instructional student manual and the teacher manual that cover the sixth set of training topics in this course for television repair technicians. Both contain identical information on the television sound reproduction circuit, including sections on the 4.5mhz beat signal detector circuit, the SIF amplifier circuit, the FM sound detector circuit, and a sound reproduction circuit. Functional block diagrams and circuit diagrams are included. (CML)

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TV TROUBLE-SHOOTING MANUAL
VOLUMES 13-14

Part 6: Sound-Reproduction Circuit

Student and Instructor's Manuals

Asian and Pacific Skill Development Programme
Islamabad, Pakistan

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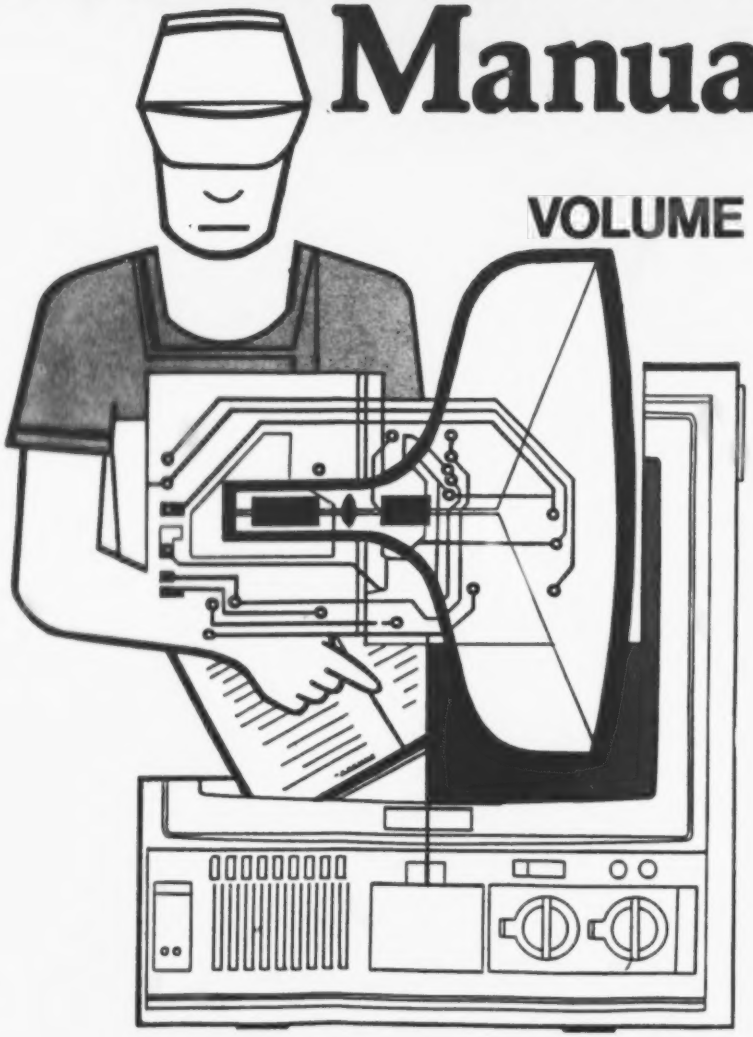
VOLUME



BY MASAAKI MUKAI AND RYOZO KOBAYASHI

OD52632

TV Trouble-shooting Manual

VOLUME 13

BY MASAAKI MUKAI AND RYOZO KOBAYASHI

Part 6: Sound-reproduction circuit

ASIAN AND PACIFIC SKILL DEVELOPMENT PROGRAMME
INTERNATIONAL LABOUR OFFICE
ISLAMABAD, PAKISTAN, 1988

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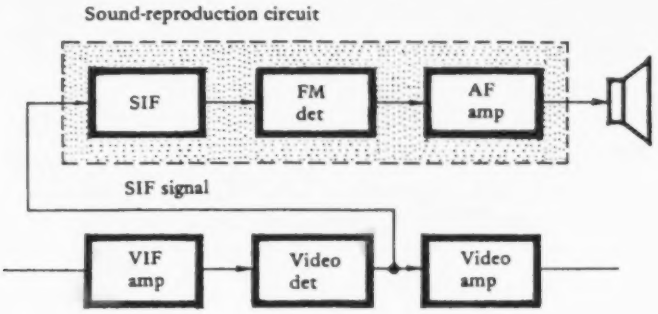
Part 6: Sound-reproduction circuit

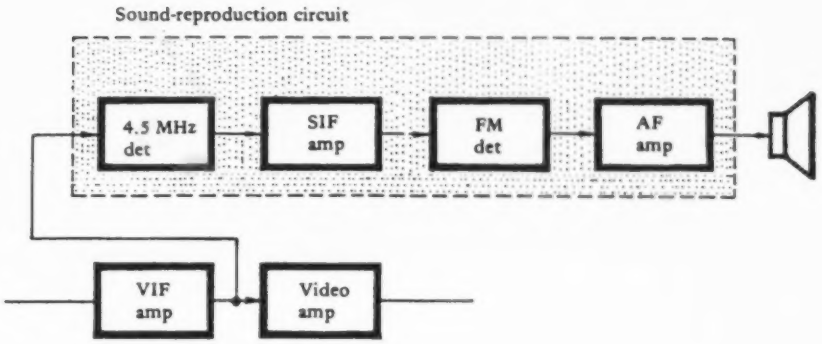
In TV broadcasting the sound signal is transmitted as a frequency-modulated (FM) signal. The carriers of the sound signal and the video signal are 4.5 MHz apart. The sound signal is reproduced by taking out the 4.5 MHz beat signal from the frequency difference between the picture and sound carrier signals. This beat is then amplified by the sound IF amplifier circuit and detected by an FM detector to recover the audio signal.

4.5 MHz beat signal-detector circuit

Figure 6-1 shows a functional block diagram of a sound circuit used in TV receiver sets. There are two ways to take out the 4.5 MHz beat signal. Generally, in monochrome receiver sets the video detector is shared as a 4.5 MHz sound detector, as shown in Figure 6-1. However, colour receivers use an independent sound-detector circuit to detect the 4.5 MHz sound IF signal.



(a) Black-and-white receiver set



(b) Colour TV set

Figure 6-1
Functional block diagram of a sound-reproduction circuit

In colour receivers, 41.25 MHz sound traps are placed at the first stage of the VIF amplifier and at the input of the video-detector circuit. These traps decrease the gain of sound signals by more than 50 dB. In addition, another 4.5 MHz trap is placed at the output of the video-detector circuit. This 4.5 MHz trap circuit is not used for the sound take-off but for minimising the 920 kHz beat interference by the 4.5 MHz sound and 3.58 MHz chroma signals. The sound take-off circuit (4.5 MHz detector circuit) is located at the last stage of the VIF amplifier circuit.

Figure 6-2 shows a 4.5 MHz sound-detector circuit. It is composed of a diode D, an inductor L and a capacitance C. When the composite video signal is coupled to the detector D, it beats the sound and the picture IF carrier signals to produce a 4.5 MHz sound IF signal. However, because of the presence of other signals within the composite video signal, the detector output contains several beat signals other than the sound signal. The succeeding tuning circuit of the detector formed by L and C passes the 4.5 MHz sound signal alone.

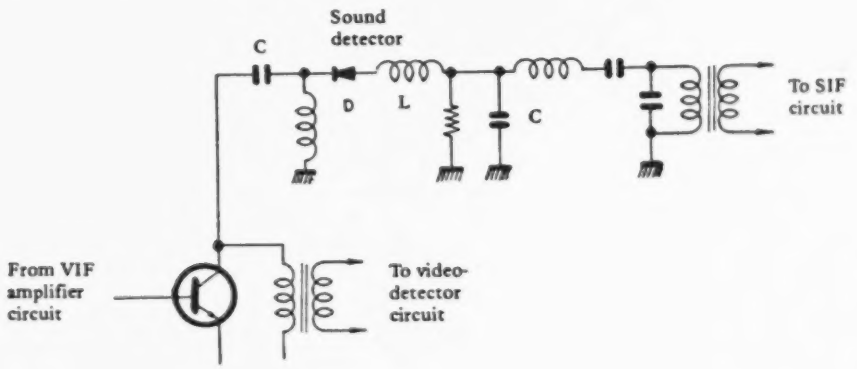


Figure 6-2
Sound-detector circuit

SIF amplifier circuit

The 4.5 MHz sound signal from the detector circuit is coupled to and amplified by the SIF amplifier to a level required by the FM detector circuit. The SIF amplifier circuit also functions as an amplitude limiter.

The maximum frequency shift of the TV FM sound signal is limited to +/- 25 kHz. The SIF amplifier circuit is designed to have a bandwidth of 100 kHz.

Since the TV signal is frequency-modulated, it is advisable for the SIF amplifier circuit to have as wide a bandwidth as possible. The required bandwidth of the SIF amplifier circuit should be at least twice the maximum frequency shift of the FM sound signal to minimise sound distortion. Since the maximum frequency shift of the sound signal is +/- 25 kHz, the minimum required bandwidth is 50 kHz. However, for allowance, the SIF amplifier circuit in most receivers is designed to have a bandwidth of around 100 kHz.

Limiter circuit

As mentioned earlier, the SIF amplifier circuit also functions as an amplitude limiter. In FM modulation, clipping the amplitude variations does not distort the frequency variations in the FM signal. The limiter circuit filters amplitude variations in the FM signal and maintains a constant amplitude FM signal. The amplitude of the FM signal which is supposed to be constant varies because of interference. If the amplitude variations in the FM signal are not filtered and are allowed to be detected by the FM detector, they will produce noise and affect the fidelity of the sound.

Figure 6-3 shows a limiter circuit. Although a large input voltage is applied to the circuit, the output circuit is designed to produce a small output voltage needed by the FM detector. In the negative cycle of the signal, the collector current is saturated at the higher level of the input voltage. On the other hand, the transistor is cut off at the higher level of the positve cycle of the signal. In effect, the positive and negative peaks of the input signal are clipped. Thus even if the input is an FM signal with amplitude variations, the output is an FM signal with a constant amplitude.

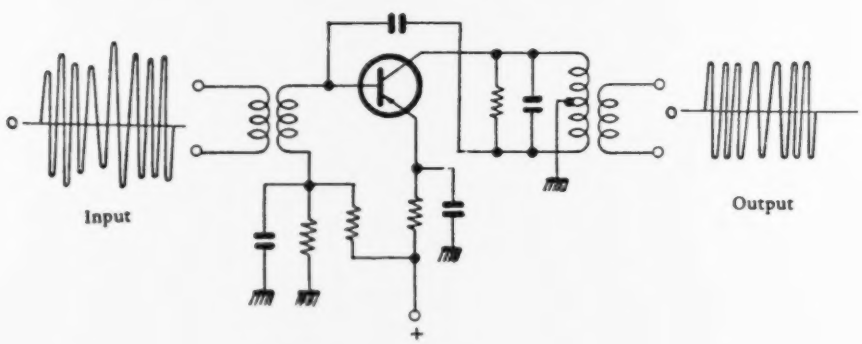


Figure 6-3
Sound IF amplifier circuit

Ceramic filter

In conventional TV circuits, as shown in Figures 6-2 and 6-3, a 4.5 MHz tuning circuit formed by coils and capacitors is used. In modern receivers a ceramic filter which requires no adjustments is commonly used. Figure 6-4 shows its application, the equivalent circuit and its frequency response. As shown in (c), the ceramic filter has a very sharp frequency response.

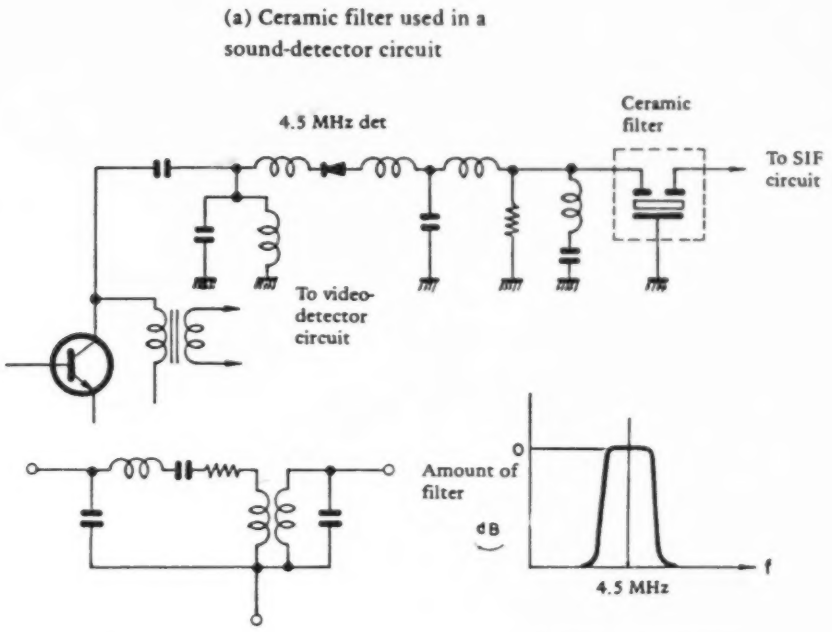


Figure 6-4
Ceramic filter

FM sound-detector circuit

The principle of the FM detector circuit

The ratio detector, an improved slope detector, is commonly used in TV receivers. It recovers the audio signal from the frequency-modulated signal.

Figure 6-5 shows a slope-detector circuit and its response curve. The sloping side of the response curve is used to convert the frequency variations into amplitude variations. As shown in Figure 6-5, corresponding frequency variations (f +/- f) in the signal are converted to corresponding amplitude variations (E +/- f). Thus an FM signal can be converted to an AM signal and vice versa.

The slope detector is a simple circuit but the linearity of its sloping response curve is poor, making it difficult to get high-quality sound reproduction. Thus a ratio detector, a slope with a better response curve, is used. In modern IC TV receiver sets a peak differential detector circuit is used.

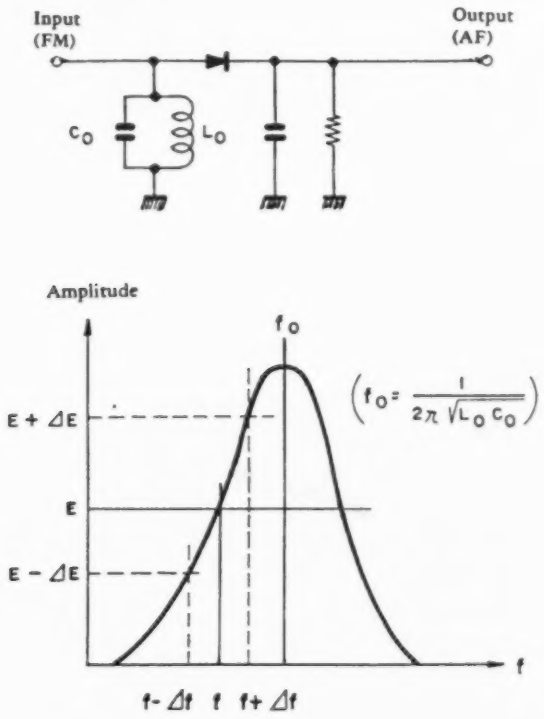


Figure 6-5
Principle of a slope-detector circuit

Ratio-detector circuit

Figure 6-6 shows a basic ratio-detector circuit. The 4.5 MHz SIF signal is coupled to the detectors D1 and D2 by the SIF transformer. The primary circuit L1 C1 and the secondary circuit L2 C2 of the SIF transformer are electromagnetically coupled and tuned to 4.5 MHz. L2 is centre-tapped by a tertiary winding L3,

which is tightly coupled to L1. A high-capacitance C5 is connected across the loads C3 C4 (C3 = C4) and R1 R2 (R1 = R2) of the detectors D1 and D2. The sound output is taken out across nodes (B) and (C) in Figure 6-6.

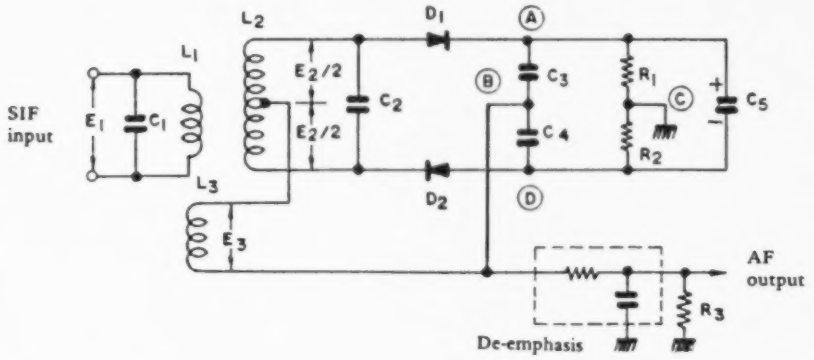


Figure 6-6
Ratio-detector circuit

Conversion of an FM signal to an AM signal. As described in the section on "The Principle of the FM Detector Circuit," the frequency-modulated SIF signal has to be converted to an amplitude-modulated signal. Let us briefly discuss how the conversion from FM to AM is done.

The primary and secondary terminal voltages of the two tuned circuits are electromagnetically coupled and tuned to the same frequency. At the resonant frequency, the phases of the primary and secondary terminal voltages are 90 degrees apart.

As the frequency of the terminal voltages shifts from the resonant frequency, the phase difference between the terminal voltages of the two tuned circuits changes. If the primary and secondary voltages are added vectorially as their phase difference varies, the vector sum varies. The variations in the frequency of the terminal voltages from the resonant frequency change their phase difference, which in turn vary the magnitude of the vector sum of the terminal voltages. Thus, frequency variations are converted into amplitude variations.

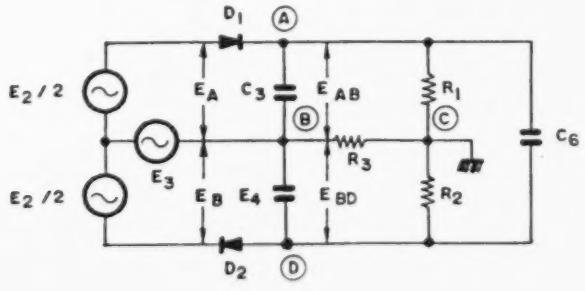


Figure 6-7
Equivalent circuit of a ratio detector

Assume that the terminal voltages of L1, L2 and L3 are E1, E2 and E3, respectively, as in Figure 6-6. Since L3 is tightly coupled to L1, E3 and E1 are in phase and have the same magnitude. Thus the vector sum described before is also the sum of E3 and E2.

The equivalent circuit of Figure 6-6 is shown in Figure 6-7. In the equivalent circuit, the input voltages are EA and EB. They are the vector sum of E3 and E2/2. Note that the magnitudes of EA and EB vary as the phase relation between the terminal voltages E2 and E3 varies.

Figure 6-8 shows a vector chart and the relations between the signal vectors. The amplitudes of EA and EB change with the variations of the input signal frequency f from the resonant frequency fo (L2,C2). From Figure 6-8 we have the following relations:

f = fo (at resonance)	EA = EB
f < fo	EA > EB
f > fo	EA < EB

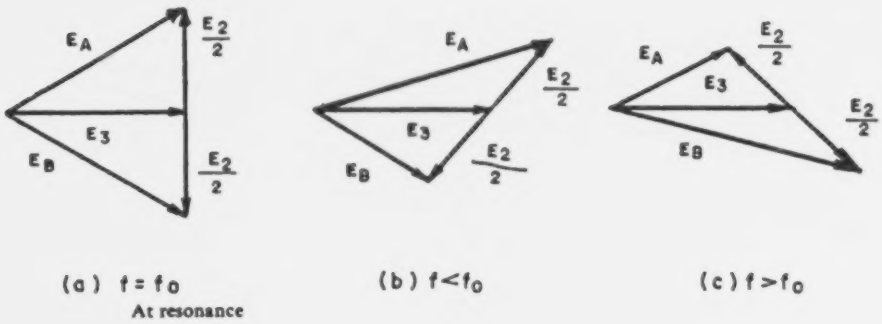


Figure 6-8
Ratio-detector operations

Operating the ratio detector. When the input volgates EA and EB are applied to D1 and D2 in Figure 6-7, respectively, they are rectified by D1 and D2. The output voltage across nodes (A),(B) and nodes (B),(D) are EAB and EBD, respectively. The level of the output is proportional to the level of EA and EB. From the circuit in Figure 6-7, we have the following relations:

$$EAB = EAC + ECB \quad \ldots . 6.1$$
$$EBD = EBC + ECD \quad \ldots . 6.2$$

Since R1 and R2 are equal, EAC is equal to ECD. Considering the direction of the current between (B) and (C), EBC is equal to - ECB. If we subtract formula 6.2 from 6.1, we get $2ECB = EAB - EBD$. Simplifying, we get

$$ECB = (EAB - EBD) / 2 \quad \ldots . 6.3$$

If the tuning circuit of the detector circuit is tuned to the input frequency, EBC becomes zero (EBC = 0) because EA = EB and thus EAB equals EBD (EAB = EBD). Therefore there will be no voltage drop across nodes (B) and (C).

If the input frequency is shifted below resonance, EAB becomes greater than EBD (EAB > EBD) and the detector output EBC becomes negative. On the other hand, if the input frequency is shifted above resonance, EAB becomes less than EBD (EAB < EBD) and the detector output EBC becomes positive. The variations in input frequency (as in frequency modulation) change the output voltage and thus produce a signal with amplitude variations or audio signal.

The relationship between the change in the input frequency and the detector output is given by the "S curve response," shown in Figure 6-9. Since a high-capacitance capacitor C5 is connected across the output of the detector circuit, as shown in Figure 6-6, and the time constant (C5 x [R1 + R2]) is set to a large value (roughly 0.1 second), a momentary change in the amplitude of the 4.5 MHz SIF signal will not affect the audio output. Thus C5 functions also as an amplitude limiter.

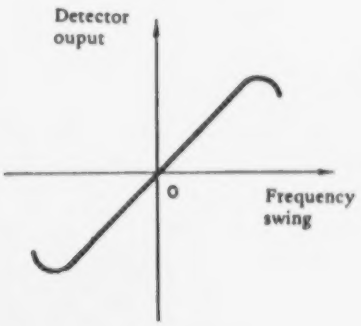


Figure 6-9
S curve of a ratio detector

Peak differential detector circuit

The peak differential detector circuit is widely used in IC TV receivers. This detector uses a single-tuned circuit and has a considerably high output voltage (around 0.7 V).

Figure 6-10 shows a peak differential detector circuit. The tuned circuit formed by L1, C1 and C2 creates a resonant frequency f2 across terminal (1) and ground and a resonant frequency f1 across terminal (2) and ground, as shown in Figure 6-11.

If the SIF voltage across terminals (1) and (2) and ground are rectified and applied differentially, the non-linear parts of the tuning response curve will compensate each other. The result is a low distortion, and a linear response detection can be obtained, as shown in the bold line of Figure 6-11.

The peak of the SIF voltage between terminal (1) and ground is detected by Q3; the peak of the SIF voltage between terminal (2) and ground, by Q4. The detected signal is coupled to the differential amplifier circuit formed by

Q5 and Q6. The audio signal is taken from the collector of Q6. Q1 and Q2 are the buffer amplifiers to increase the SIF signal.

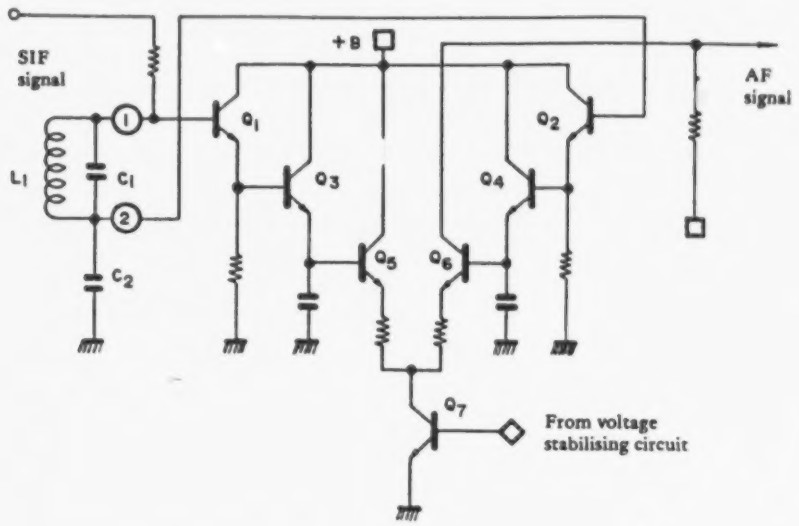


Figure 6-10
Peak differential detector circuit

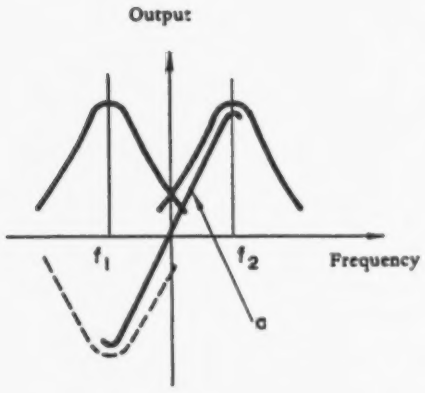


Figure 6-11
FM detector response

De-emphasis

In FM transmission the S/N ratio of the signal decreases at higher modulation frequencies. The decrease is compensated at the transmitter by boosting the strength of the modulation at higher modulation frequencies. This is called *pre-emphasis*. If this pre-emphasised signal is detected and amplified as is, a high-frequency emphasised audio signal is reproduced.

To get a normal audio signal, the receiver should have a *de-emphasis* network. The de-emphasis circuit in the receiver neutralises the effect of the pre-

emphasis circuit in the transmitter. Although there is no net boost in the strength of the signal, the S/N ratio of the signal improves.

Figure 6-12 shows the pre-emphasis and de-emphasis circuits and their respective frequency response curves. In TV broadcasts the standard time constant for the sound pre-emphasis is set to 75 microseconds. The de-emphasis circuit of the receiver should also have a time constant of 75 microseconds.

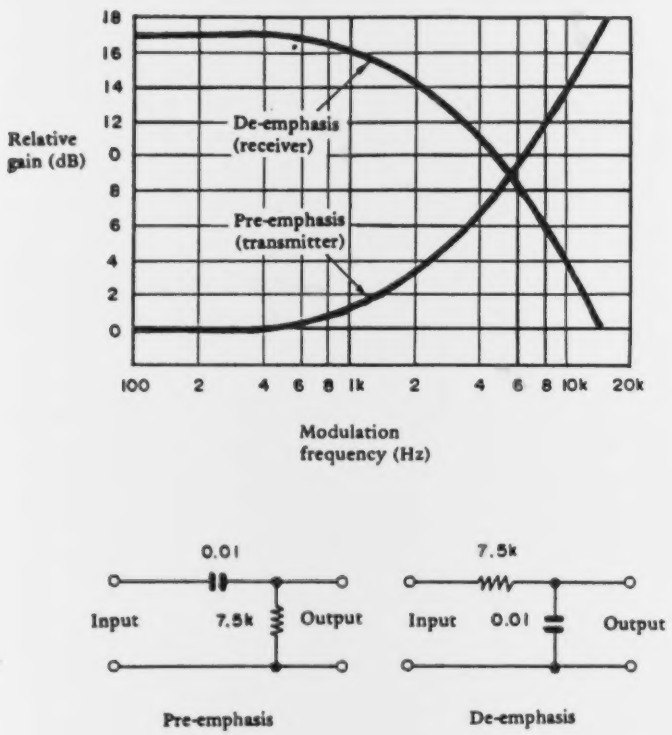


Figure 6-12
Emphasis circuit and its frequency characteristics

A sound-reproduction circuit

Most of the sound-reproduction circuits of modern receivers use ICs. A transistor class-A amplifier circuit is generally used to drive the loudspeaker.

Figure 6-13 shows a sound-reproduction circuit. The detector output of the 4.5 MHz sound take-off circuit is coupled to the IC by a ceramic filter. The 4.5 MHz SIF amplifier, limiter, FM detector, de-emphasis and AF pre-amplifier circuits are included in the IC chip. The output of the IC is amplified by a single stage of a class-A amplifier circuit to drive the loud speakers. The level of the audio signal in this circuit is controlled by varying the level of the DC supply voltage of the IC.

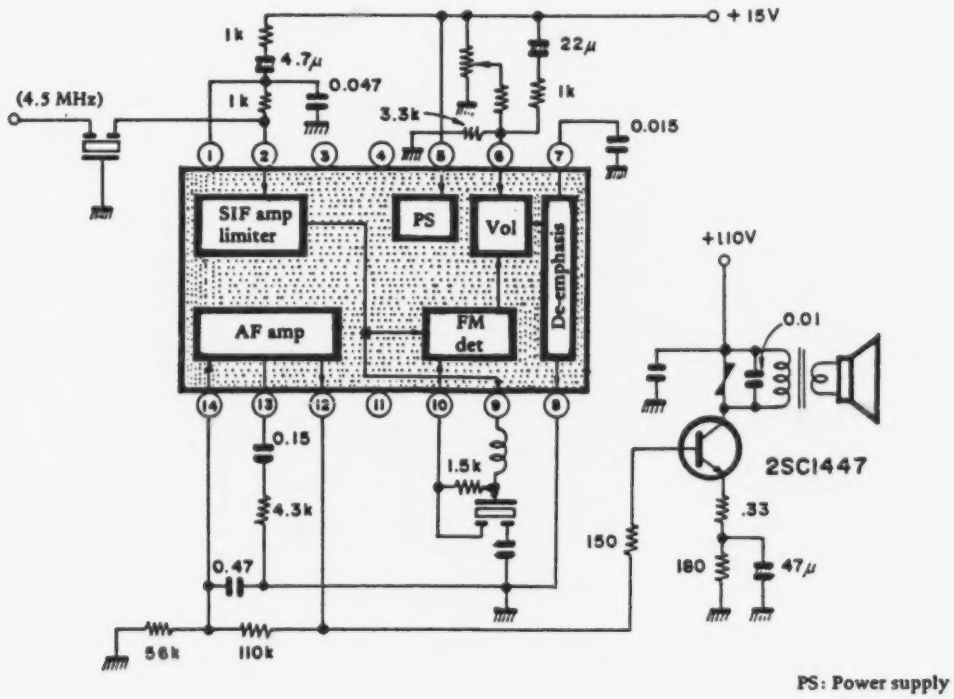


Figure 6-13
An actual sound-reproduction circuit

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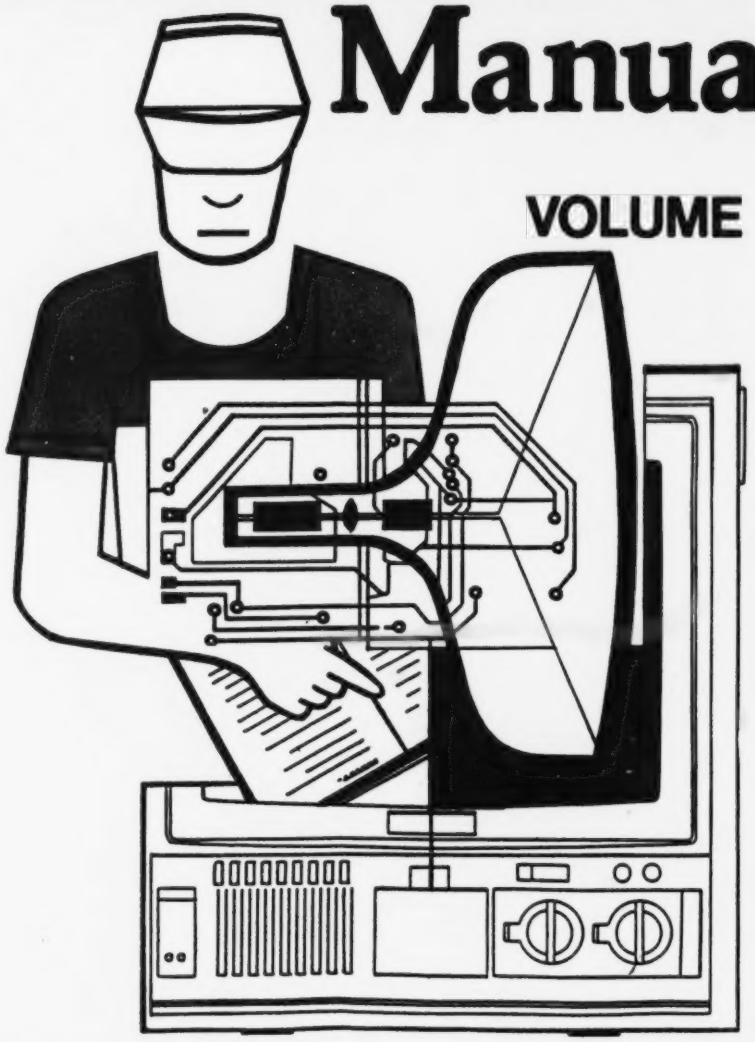

BY MASAAKI MUKAI AND RYOZO KOBAYASHI

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Teaching and training material for instructors for the training of television set technicians – Explains the function of a 4.5 MHz beat signal-detector circuit, SIF amplifier circuit, FM sound-detector circuit, etc. Block diagrams.

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TV Trouble-shooting Manual

VOLUME 14

BY MASAAKI MUKAI AND RYOZO KOBAYASHI

Part 6: Sound-reproduction circuit (Instructor's manual)

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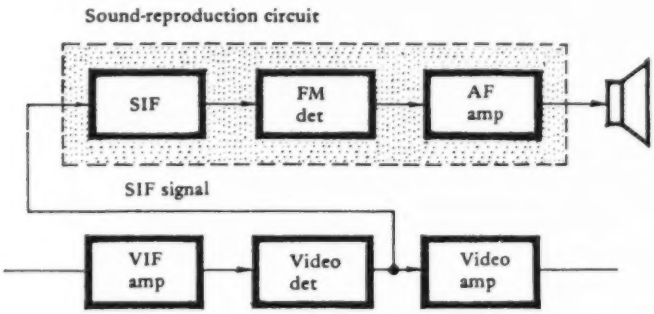

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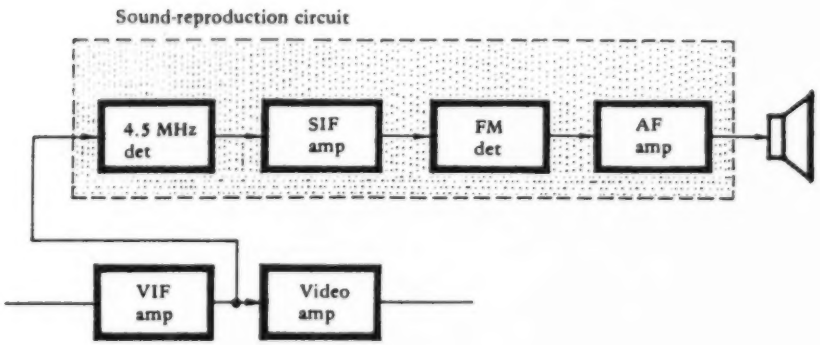

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In colour receivers, 41.25 MHz sound traps are placed at the first stage of the VIF amplifier and at the input of the video-detector circuit. These traps decrease the gain of sound signals by more than 50 dB. In addition, another 4.5 MHz trap is placed at the output of the video-detector circuit. This 4.5 MHz trap circuit is not used for the sound take-off but for minimising the 920 kHz beat interference by the 4.5 MHz sound and 3.58 MHz chroma signals. The sound take-off circuit (4.5 MHz detector circuit) is located at the last stage of the VIF amplifier circuit.

Figure 6-2 shows a 4.5 MHz sound-detector circuit. It is composed of a diode D, an inductor L and a capacitance C. When the composite video signal is coupled to the detector D, it beats the sound and the picture IF carrier signals to produce a 4.5 MHz sound IF signal. However, because of the presence of other signals within the composite video signal, the detector output contains several beat signals other than the sound signal. The succeeding tuning circuit of the detector formed by L and C passes the 4.5 MHz sound signal alone.

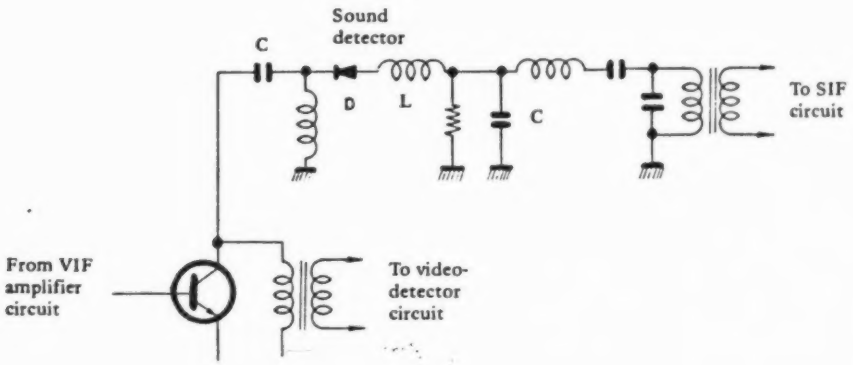

Figure 6-2
Sound-detector circuit

SIF amplifier circuit

The 4.5 MHz sound signal from the detector circuit is coupled to and amplified by the SIF amplifier to a level required by the FM detector circuit. The SIF amplifier circuit also functions as an amplitude limiter.

The maximum frequency shift of the TV FM sound signal is limited to +/- 25 kHz. The SIF amplifier circuit is designed to have a bandwidth of 100 kHz.

Since the TV signal is frequency-modulated, it is advisable for the SIF amplifier circuit to have as wide a bandwidth as possible. The required bandwidth of the SIF amplifier circuit should be at least twice the maximum frequency shift of the FM sound signal to minimise sound distortion. Since the maximum frequency shift of the sound signal is +/- 25 kHz, the minimum required bandwidth is 50 kHz. However, for allowance, the SIF amplifier circuit in most receivers is designed to have a bandwidth of around 100 kHz.

Limiter circuit

As mentioned earlier, the SIF amplifier circuit also functions as an amplitude limiter. In FM modulation, clipping the amplitude variations does not distort the frequency variations in the FM signal. The limiter circuit filters amplitude variations in the FM signal and maintains a constant amplitude FM signal. The amplitude of the FM signal which is supposed to be constant varies because of interference. If the amplitude variations in the FM signal are not filtered and are allowed to be detected by the FM detector, they will produce noise and affect the fidelity of the sound.

Figure 6-3 shows a limiter circuit. Although a large input voltage is applied to the circuit, the output circuit is designed to produce a small output voltage needed by the FM detector. In the negative cycle of the signal, the collector current is saturated at the higher level of the input voltage. On the other hand, the transistor is cut off at the higher level of the positve cycle of the signal. In effect, the positive and negative peaks of the input signal are clipped. Thus even if the input is an FM signal with amplitude variations, the output is an FM signal with a constant amplitude.

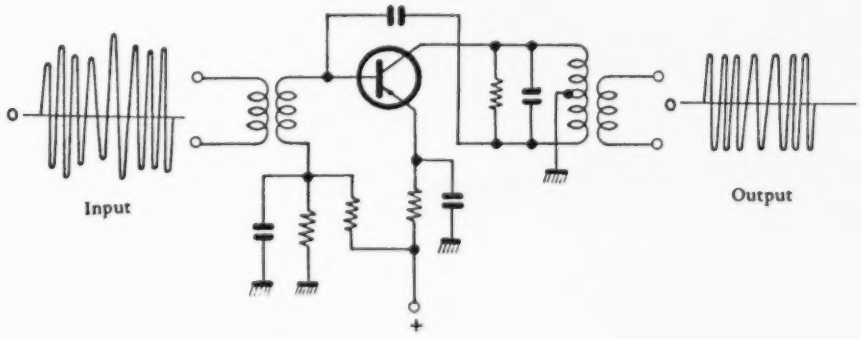

Figure 6-3
Sound IF amplifier circuit

Ceramic filter

In conventional TV circuits, as shown in Figures 6-2 and 6-3, a 4.5 MHz tuning circuit formed by coils and capacitors is used. In modern receivers a ceramic filter which requires no adjustments is commonly used. Figure 6-4 shows its application, the equivalent circuit and its frequency response. As shown in (c), the ceramic filter has a very sharp frequency response.

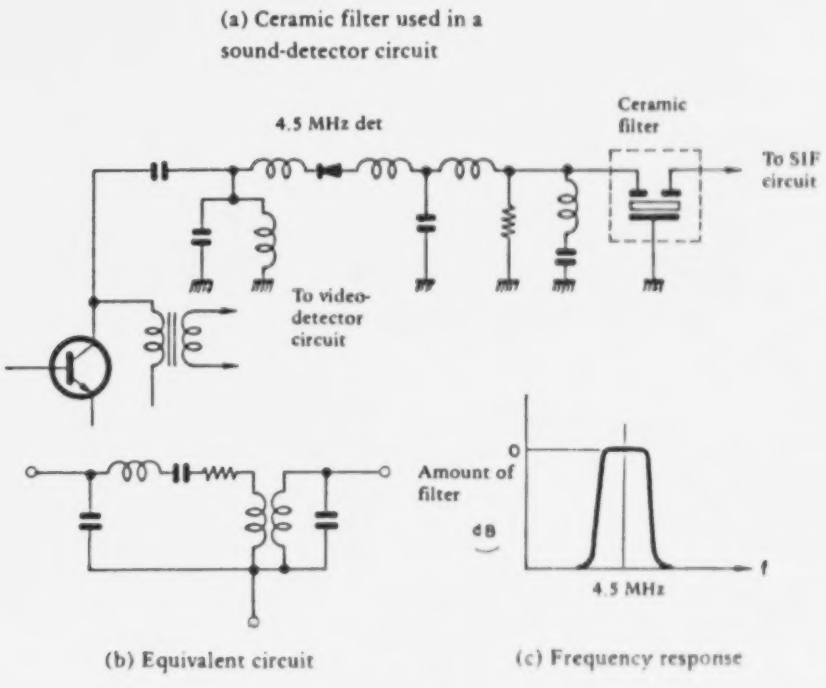

Figure 6-4
Ceramic filter

FM sound-detector circuit

The principle of the FM detector circuit

The ratio detector, an improved slope detector, is commonly used in TV receivers. It recovers the audio signal from the frequency-modulated signal.

Figure 6-5 shows a slope-detector circuit and its response curve. The sloping side of the response curve is used to convert the frequency variations into amplitude variations. As shown in Figure 6-5, corresponding frequency variations (f +/- f) in the signal are converted to corresponding amplitude variations (E +/- f). Thus an FM signal can be converted to an AM signal and vice versa.

The slope detector is a simple circuit but the linearity of its sloping response curve is poor, making it difficult to get high-quality sound reproduction. Thus a ratio detector, a slope with a better response curve, is used. In modern IC TV receiver sets a peak differential detector circuit is used.

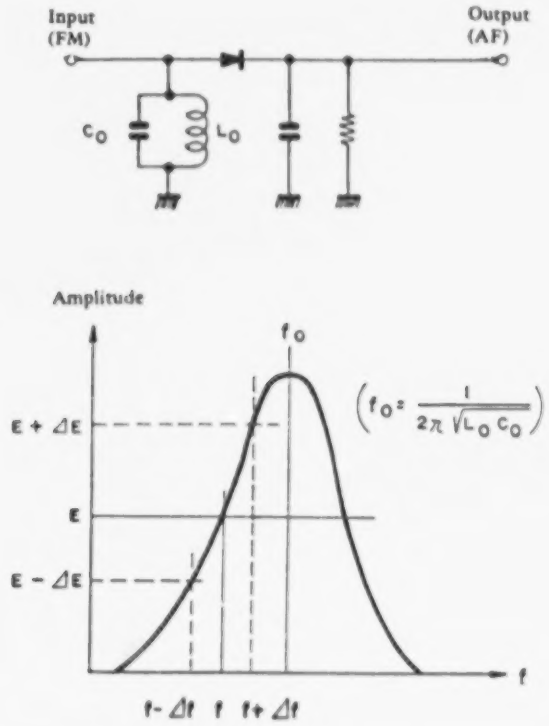

Figure 6-5
Principle of a slope-detector circuit

Ratio-detector circuit

Figure 6-6 shows a basic ratio-detector circuit. The 4.5 MHz SIF signal is coupled to the detectors D1 and D2 by the SIF transformer. The primary circuit L1 C1 and the secondary circuit L2 C2 of the SIF transformer are electromagnetically coupled and tuned to 4.5 MHz. L2 is centre-tapped by a tertiary winding L3,

which is tightly coupled to L1. A high-capacitance C5 is connected across the loads C3 C4 (C3 = C4) and R1 R2 (R1 = R2) of the detectors D1 and D2. The sound output is taken out across nodes (B) and (C) in Figure 6-6.

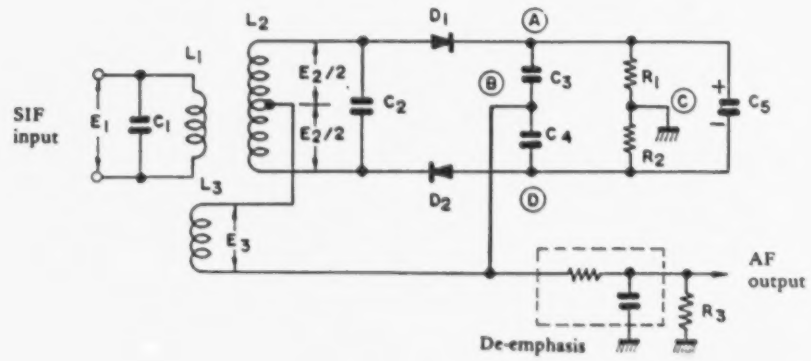

Figure 6-6
Ratio-detector circuit

Conversion of an FM signal to an AM signal. As described in the section on "The Principle of the FM Detector Circuit," the frequency-modulated SIF signal has to be converted to an amplitude-modulated signal. Let us briefly discuss how the conversion from FM to AM is done.

The primary and secondary terminal voltages of the two tuned circuits are electromagnetically coupled and tuned to the same frequency. At the resonant frequency, the phases of the primary and secondary terminal voltages are 90 degrees apart.

As the frequency of the terminal voltages shifts from the resonant frequency, the phase difference between the terminal voltages of the two tuned circuits changes. If the primary and secondary voltages are added vectorially as their phase difference varies, the vector sum varies. The variations in the frequency of the terminal voltages from the resonant frequency change their phase difference, which in turn vary the magnitude of the vector sum of the terminal voltages. Thus, frequency variations are converted into amplitude variations.

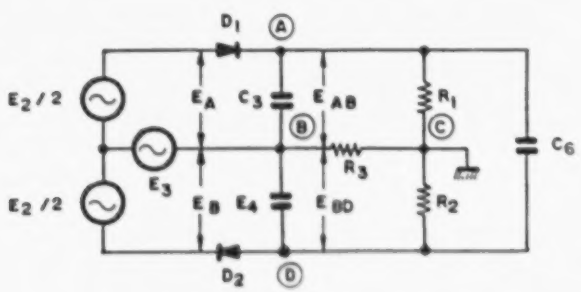

Figure 6-7
Equivalent circuit of a ratio detector

Assume that the terminal voltages of L1, L2 and L3 are E1, E2 and E3, respectively, as in Figure 6-6. Since L3 is tightly coupled to L1, E3 and E1 are in phase and have the same magnitude. Thus the vector sum described before is also the sum of E3 and E2.

The equivalent circuit of Figure 6-6 is shown in Figure 6-7. In the equivalent circuit, the input voltages are EA and EB. They are the vector sum of E3 and E2/2. Note that the magnitudes of EA and EB vary as the phase relation between the terminal voltages E2 and E3 varies.

Figure 6-8 shows a vector chart and the relations between the signal vectors. The amplitudes of EA and EB change with the variations of the input signal frequency f from the resonant frequency fo (L2,C2). From Figure 6-8 we have the following relations:

f = fo (at resonance)	EA = EB
f < fo	EA > EB
f > fo	EA < EB

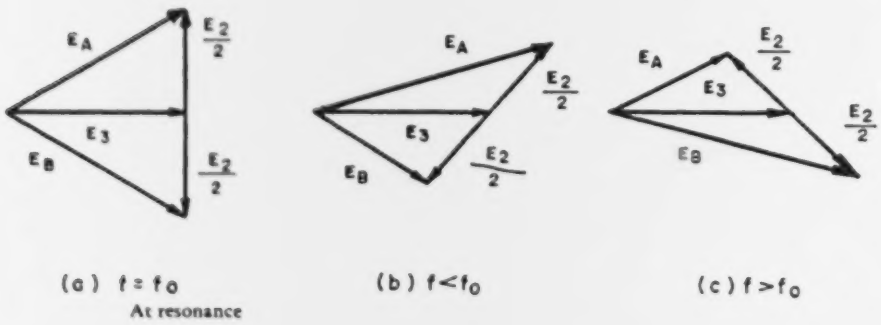

Figure 6-8
Ratio-detector operations

Operating the ratio detector. When the input volgates EA and EB are applied to D1 and D2 in Figure 6-7, respectively, they are rectified by D1 and D2. The output voltage across nodes (A),(B) and nodes (B),(D) are EAB and EBD, respectively. The level of the output is proportional to the level of EA and EB. From the circuit in Figure 6-7, we have the following relations:

EAB = EAC + ECB 6.1
EBD = EBC + ECD 6.2

Since R1 and R2 are equal, EAC is equal to ECD. Considering the direction of the current between (B) and (C), EBC is equal to - ECB. If we subtract formula 6.2 from 6.1, we get 2ECB = EAB - EBD. Simplifying, we get

ECB = (EAB - EBD) / 2 .... 6.3

If the tuning circuit of the detector circuit is tuned to the input frequency, EBC becomes zero (EBC = 0) because EA = EB and thus EAB equals EBD (EAB = EBD). Therefore there will be no voltage drop across nodes (B) and (C).

If the input frequency is shifted below resonance, EAB becomes greater than EBD (EAB > EBD) and the detector output EBC becomes negative. On the other hand, if the input frequency is shifted above resonance, EAB becomes less than EBD (EAB < EBD) and the detector output EBC becomes positive. The variations in input frequency (as in frequency modulation) change the output voltage and thus produce a signal with amplitude variations or audio signal.

The relationship between the change in the input frequency and the detector output is given by the "S curve response," shown in Figure 6-9. Since a high-capacitance capacitor C5 is connected across the output of the detector circuit, as shown in Figure 6-6, and the time constant (C5 x [R1 + R2]) is set to a large value (roughly 0.1 second), a momentary change in the amplitude of the 4.5 MHz SIF signal will not affect the audio output. Thus C5 functions also as an amplitude limiter.

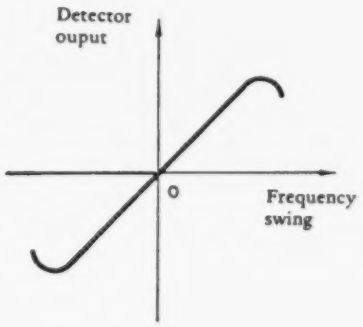

Figure 6-9
S curve of a ratio detector

Peak differential detector circuit

The peak differential detector circuit is widely used in IC TV receivers. This detector uses a single-tuned circuit and has a considerably high output voltage (around 0.7 V).

Figure 6-10 shows a peak differential detector circuit. The tuned circuit formed by L1, C1 and C2 creates a resonant frequency f2 across terminal (1) and ground and a resonant frequency f1 across terminal (2) and ground, as shown in Figure 6-11.

If the SIF voltage across terminals (1) and (2) and ground are rectified and applied differentially, the non-linear parts of the tuning response curve will compensate each other. The result is a low distortion, and a linear response detection can be obtained, as shown in the bold line of Figure 6-11.

The peak of the SIF voltage between terminal (1) and ground is detected by Q3; the peak of the SIF voltage between terminal (2) and ground, by Q4. The detected signal is coupled to the differential amplifier circuit formed by

Q5 and Q6. The audio signal is taken from the collector of Q6. Q1 and Q2 are the buffer amplifiers to increase the SIF signal.

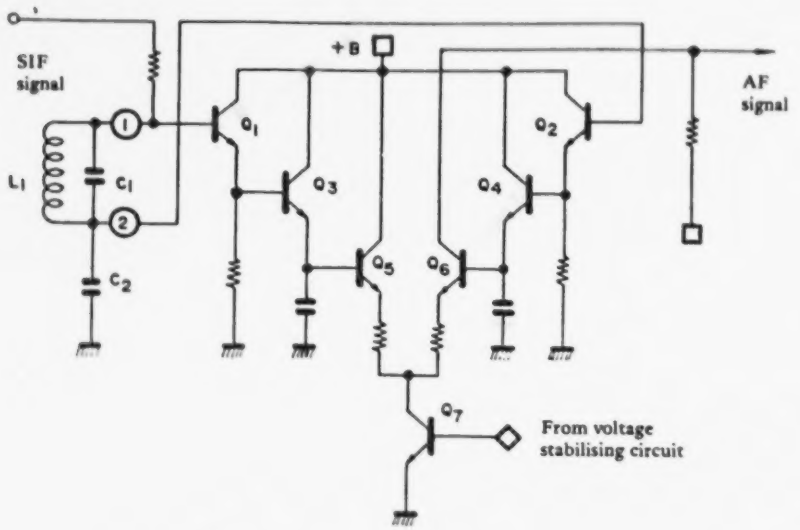

Figure 6-10
Peak differential detector circuit

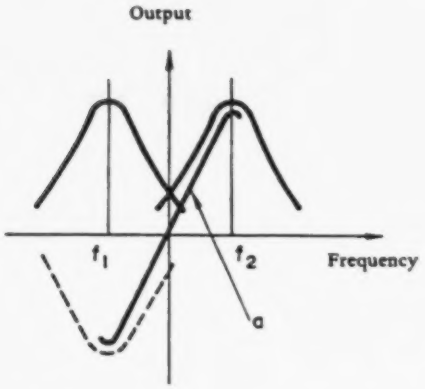

Figure 6-11
FM detector response

De-emphasis

In FM transmission the S/N ratio of the signal decreases at higher modulation frequencies. The decrease is compensated at the transmitter by boosting the strength of the modulation at higher modulation frequencies. This is called *pre-emphasis*. If this pre-emphasised signal is detected and amplified as is, a high-frequency emphasised audio signal is reproduced.

To get a normal audio signal, the receiver should have a *de-emphasis* network. The de-emphasis circuit in the receiver neutralises the effect of the pre-

emphasis circuit in the transmitter. Although there is no net boost in the strength of the signal, the S/N ratio of the signal improves.

Figure 6-12 shows the pre-emphasis and de-emphasis circuits and their respective frequency response curves. In TV broadcasts the standard time constant for the sound pre-emphasis is set to 75 microseconds. The de-emphasis circuit of the receiver should also have a time constant of 75 microseconds.

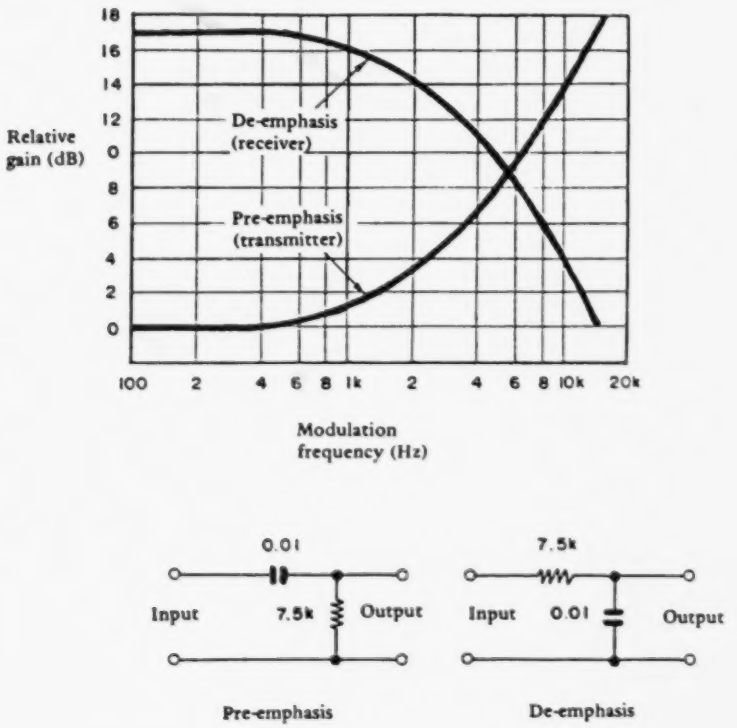

Figure 6-12
Emphasis circuit and its frequency characteristics

A sound-reproduction circuit

Most of the sound-reproduction circuits of modern receivers use ICs. A transistor class-A amplifier circuit is generally used to drive the loudspeaker.

Figure 6-13 shows a sound-reproduction circuit. The detector output of the 4.5 MHz sound take-off circuit is coupled to the IC by a ceramic filter. The 4.5 MHz SIF amplifier, limiter, FM detector, de-emphasis and AF pre-amplifier circuits are included in the IC chip. The output of the IC is amplified by a single stage of a class-A amplifier circuit to drive the loud speakers. The level of the audio signal in this circuit is controlled by varying the level of the DC supply voltage of the IC.

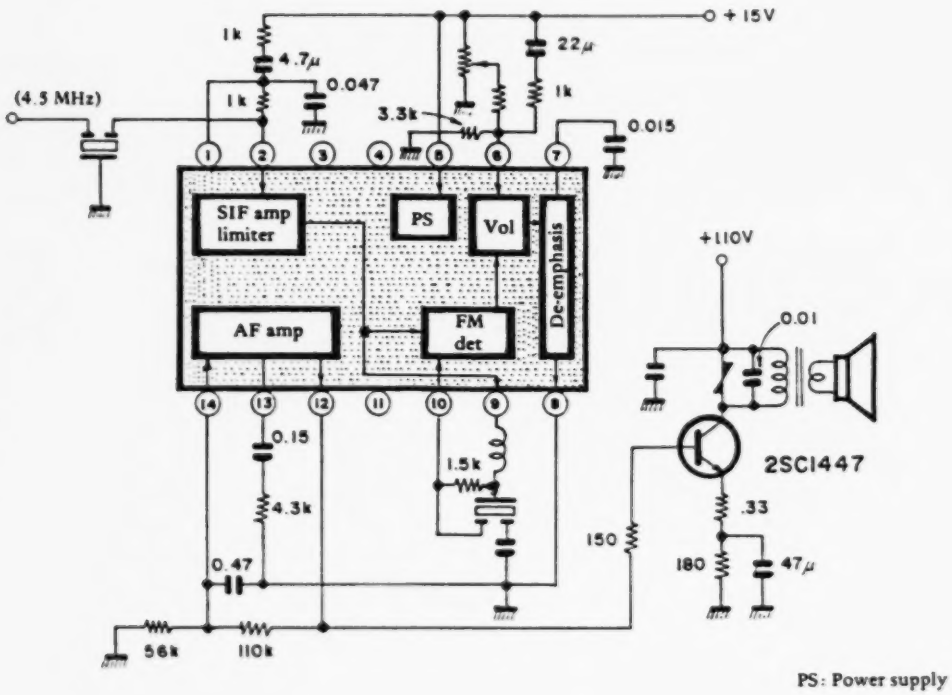

Figure 6-13
An actual sound-reproduction circuit

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